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ELEMENTARY PHYSIOLOGY

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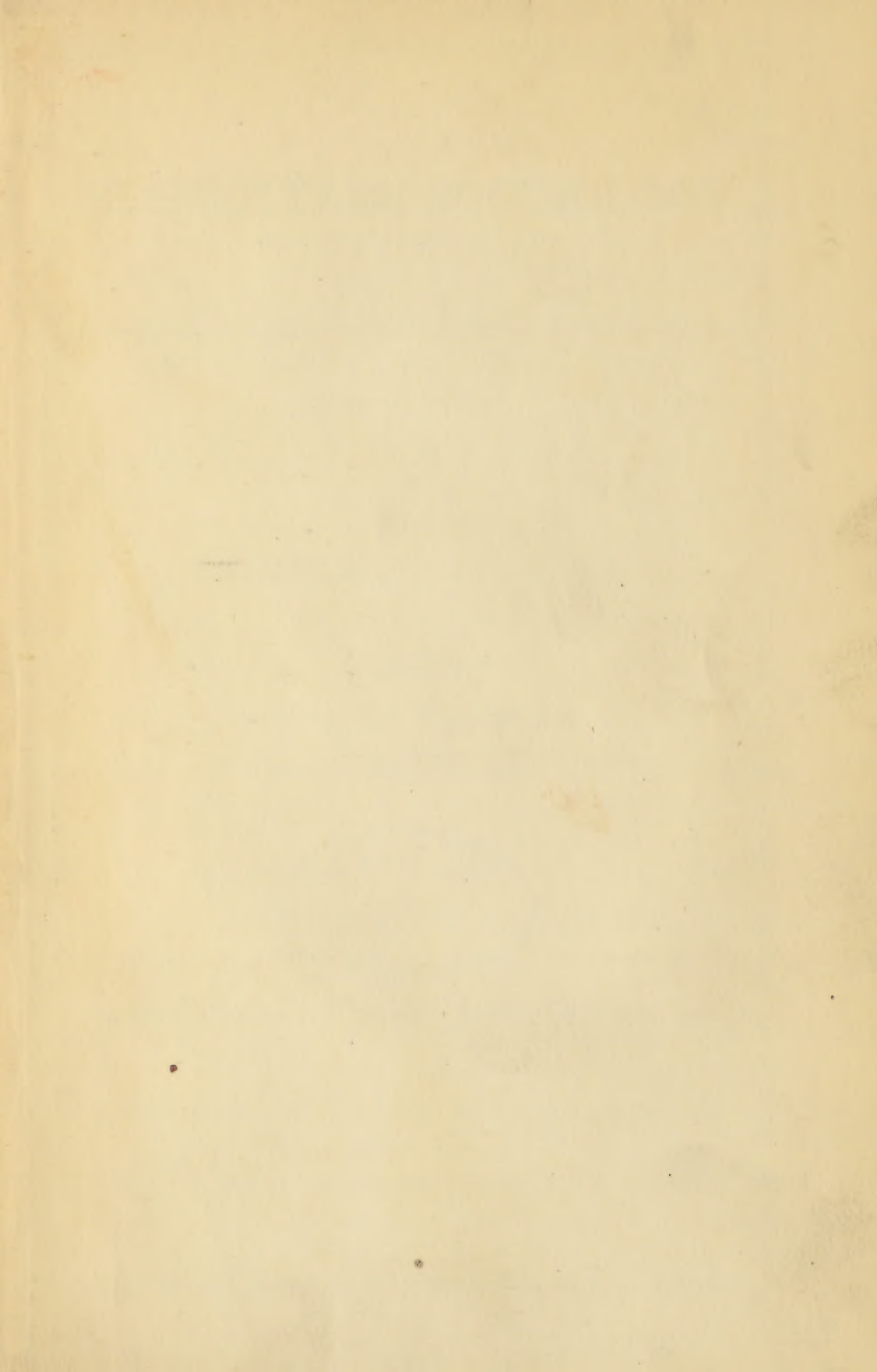
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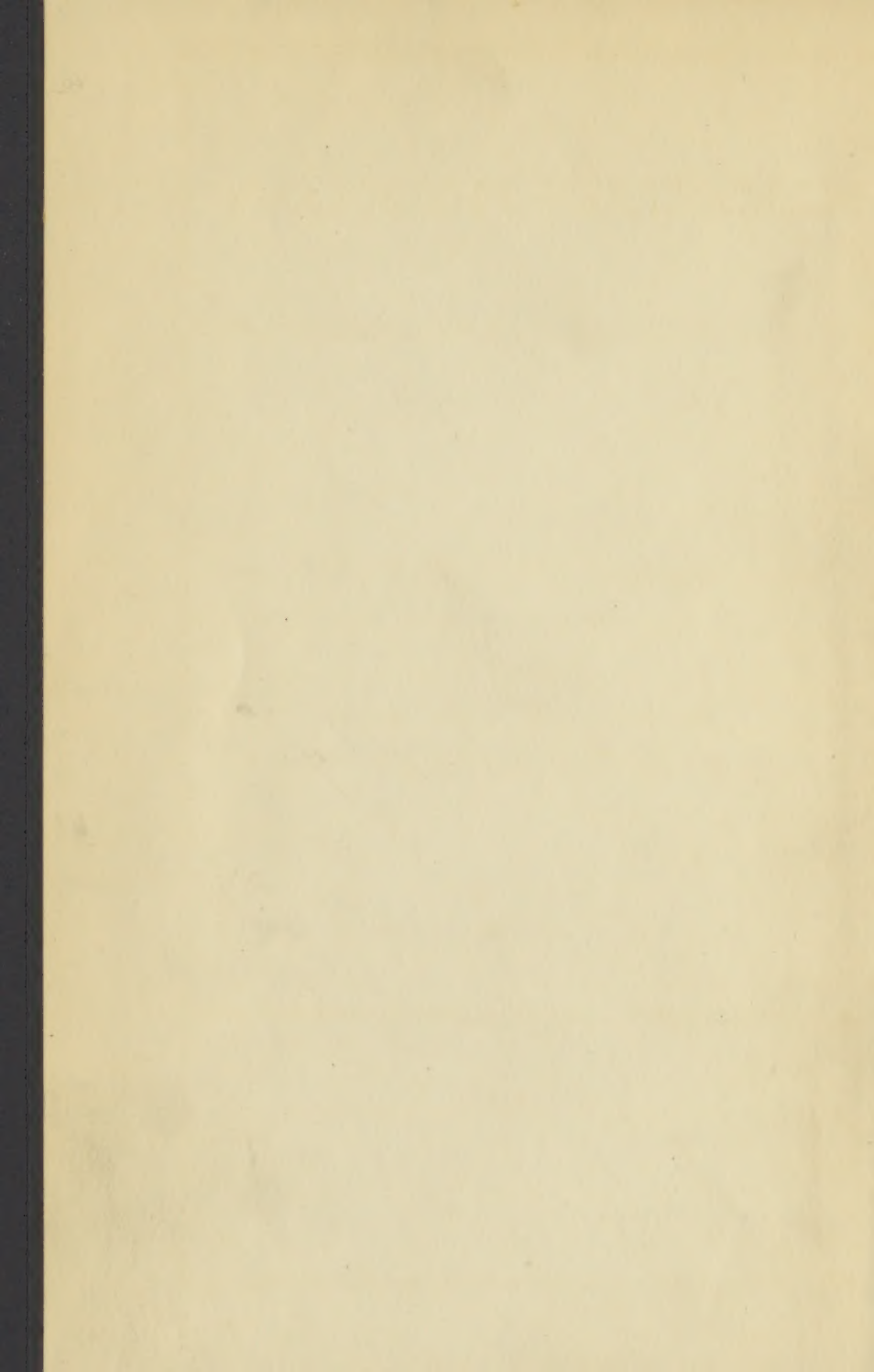
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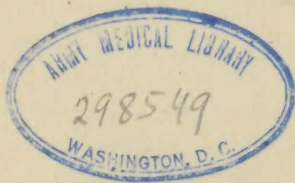
ELEMENTARY PHYSIOLOGY

INSTRUCTION PAPER

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ELEMENTARY PHYSIOLOGY

GENERAL DIRECTIONS TO STUDENT

The following directions and outlines are based upon the textbook "Sanitation and Physiology" by John W. Ritchie, and the answers to most of the questions will be found in that book. If you have access to other books of physiology, you will find it helpful to read what other authors say concerning the various topics. The outlines do not require the use of a compound microscope, but if you have a friend that is a physician or a medical student ask him to let you use his instrument and look at the slides of the various tissues which he is sure to have.

Glance through your textbook and note its general plan. Physiology primarily means the study of the functions of the various organs of the body. But since one cannot understand the functions of organs without knowing about their structure, anatomy is usually included in the study of physiology. Again, as only a healthy organ can do its work properly, it is important that we should study about the hygiene, or care, of the various organs. Finally, since the real object in studying physiology is to learn to care for the body and keep it in health, we should study the general problems of sanitation. You will see that your textbook, therefore, covers all these topics. Part I treats of sanitation; Part II of the other topics; however, in this course Part II of the text will be considered before Part I. There are a glossary and an index at the end of each part, which you should use constantly.

In preparing your lessons proceed as follows: First read through carefully the chapters or pages assigned. Then turn to the questions and write out the answers. These answers may often be brief, but they should always be complete and in the form of a statement. Number each answer to correspond with the number of the question. At the top of each set of answers write the topic and the number of the lesson. Write all answers in ink and pay attention to the neatness and appearance of your paper. For the notebook in which your answers are to be written you will find some form of loose-leaf notebook most convenient.

This outline has been divided into ten parts, with examination papers at the end of each two parts. When you have written out the answers for each two parts and the corresponding examination, send in both notebook and examination for correction.

PART I

INTRODUCTION

LESSON 1

THE CELL

Read Chapters I and III, Part II.

1. Of what is the human body composed?
2. Define the term "cell."

The word "cell" really means a hollow space, that is, cells of the honeycomb. This is what the scientists who first discovered the cell (1838-39) thought the structure of the cell to be. It was later discovered that it was the substance (protoplasm) within the wall that was the living part. In fact, some cells have no walls at all. The nucleus and cytoplasm are simply parts of the protoplasm.

3. What is the structure of the simplest animal?

Place some bits of organic material, that is, hay, decaying plants from a ditch, etc., in a glass of water, and leave the glass uncovered for several days. Note the little white specks moving around. These are simple animals similar to the one shown in Fig. 3. These can be seen quite easily with a hand lens or reading glass, but you must examine them under a compound microscope to discern the parts as shown in the figure. How do these animals happen to appear in the glass of water?

4. Show how the bodies of the larger animals originate.

Break a hen's egg in a saucer. Observe the white albumen and the yellow yolk. On the latter find a small white area. This is the germ (cell) from which the chick develops. What is the use of the albumin and the yolk? All higher animals develop from eggs and the egg is only one cell.

5. How does the body of a higher animal grow?
6. Show why the higher animals, composed of many cells, must also have different kinds of cells.
7. Are these different groups of cells independent or dependent upon one another? Why?
8. In the human body what controls the various organs and thus enables the cells to work together?
9. Study Fig. 5. What is a tissue? To what is the structure of the different tissues due? What is an organ? How many kinds of tissue are there in an organ?
10. State three important reasons for knowing something about cells before beginning the study of the physiology of the human body.

LESSON 2

GENERAL PLAN OF HUMAN BODY

Read Chapter II.

The animal kingdom has been divided by scientists into a number of groups. The highest group includes those animals with a backbone. These animals are called *vertebrates*. The other groups are often spoken of collectively as *invertebrates*. In this latter division are such animals as insects, worms, crayfish, clams, corals, one-celled animals, etc.; the skeleton, if present, is on the outside of the animal, as the shell of a clam or oyster.

1. To which of the two great groups of the animal kingdom does man belong? Why?

Study Fig. 11 carefully and read the fine print at the bottom of p. 18.

2. Name the five classes of vertebrates. To which class does man belong? What other mammal is nearest to man in structure?

3. State four ways in which the structure of the human body resembles that of other vertebrates.

4. State two important differences between man and other vertebrates.

5. What are the three divisions of the human body?

6. Study Fig. 8. How many and what cavities are shown? What separates the thoracic from the abdominal cavity?

7. Study Fig. 9. What organs are found in the thoracic cavity; in the abdominal cavity?

8. How do the arms and the legs of man differ in function?

If possible visit some museum, or, better, some zoölogical garden, and observe the monkeys and apes. Note the difference in the length of arms and in the use of both arms and legs as compared with man.

9. How are the limbs modified in the case of fish, seals, and birds? What is the reason for this?

10. Is the foot parallel or at right angles to the leg in the case of man? Why?

11. In standing, or walking, the heel rests on the ground. Does it do this in running?

Look in some textbook of zoölogy or natural history and note the location of the heel in some of the common mammals. What is the hock in case of the horse? Why is a bear so awkward in walking? (Study Fig. 33.)

12. You can move your thumb sidewise and touch each one of the fingers. What advantage is thus gained? How is the movement of the big toe different from that of the thumb? How do apes differ in this respect?

There are cases on record where persons have lost both arms through accident and have learned to hold a pencil and write with their feet. What does this suggest?

PART II

SKELTON AND MUSCLES

LESSON 3

THE SKELTON

Read Chapters IV and V.

1. Name the three functions of the skeleton.
2. How many bones compose the skeleton? What are the three groups?
3. How may bones be classified with respect to their shapes?
4. What is the purpose of the long bones?

Rest your elbow on a table and hold in your hand a foot rule parallel to the arm, keeping the forearm on the table. Bend the elbow until the forearm and the ruler are vertical. Repeat, using a yardstick instead of a foot rule. State the difference in the two cases in the distance the tip moved and the rate of movement.

5. What advantages are gained by having the fingers composed of several short bones?

6. Why are so many of the long bones hollow?

7. In general, what is the difference between the functions of flat bones and cylindrical bones?

8. What is the purpose in having irregular bones in the skeleton?

9. What are the two kinds of material in bones? What is the purpose of each? How does the relative amount of each vary with age?

Try the experiment suggested on p. 39 of the textbook.

10. What is the difference between the character of the bone substance on the outside and that on the inside of most bones? Why are the shafts of long bones composed only of compact bone? Where is the spongy bone? See Fig. 25.

11. What is the periosteum? What is its importance?

12. What fills the cavities of bones? What is marrow? Why is that found in spongy bones of a reddish color?

13. How does a bone grow in thickness? How does a long bone increase in length?

14. What kinds of joints would you expect to find in the parts of the skeleton where the function is to protect; where the function is to aid in motion? Name an instance of each kind.

15. Name three kinds of movable joints; give an example of each kind.

16. Study Fig. 26. What is found in the spaces among the cells? Is the character of cartilage due to the cells or to the inter-cellular substance? How is the latter formed?

17. Name two ways in which friction is prevented at the joints.

18. What are ligaments? What is their function?

19. Study Fig. 17. What three groups of bones compose the skull? How is the cranium especially well adapted for its purpose?

20. Study Fig. 21. Observe the solid cylindrical part (body, or centrum), the ring-like portion, and the various projections (processes) of the vertebrae. What do you feel when you run your hand down the middle of your back? What passes through the cavity of the ring-like part? The vertebral column, Figs. 18 and 21, is also called the spinal column, or simply the spine.

21. What is between each two vertebrae? Give two reasons why the vertebral column should consist of short bones.

The first two vertebrae are quite different from the others. The first is simply a ring; when you nod your head you move the skull on this vertebra. The second vertebra has a little peg; when you turn your head, the skull and the first vertebra revolve on this peg.

22. In general, what is the purpose of the ribs? How are they attached to the axial skeleton? State the number of ribs and distinguish between true and false ribs. What are floating ribs?

23. Refer to Fig. 33 and compare the bones of the limbs. Show how the arrangement of the bones in the arm is similar to that of the leg bones. What are the differences?

24. How many and what bones are in the shoulder? To what is the arm joined? How does the clavicle brace the shoulder?

25. To what part of the skeleton is the leg joined? What is the function of the pelvis?

26. State the three means by which, through the arrangement of the parts of the skeleton, springiness is secured. Why is this important?

The two bones of the forearm make it possible to turn the hand. The hand is attached chiefly to the radius, and in turning, the radius is partly swung over the ulna.

LESSON 4

THE MUSCLES

Read Chapter VI.

1. State three important functions of the muscles.
2. What are the two great classes of muscles? How do they differ?

3. Study Fig. 39. What does the biceps muscle do; the triceps? Why are these muscles called antagonistic muscles?

It is important to keep in mind the fact that muscles can do only one thing; that is, contract. A muscle therefore can *pull* but never *push*. We speak of the contraction and the relaxation, not the contraction and the expansion of muscles. Note that the biceps muscle when contracted, while shorter, has a greater thickness so that the volume (amount of space it fills) remains the same. When a piece of iron contracts, its volume becomes less.

4. State how antagonistic muscles are advantageous.

5. Study Fig. 35; this shows the structure of a voluntary muscle. What covers the muscle?

6. How are the cells arranged within the covering of the muscle?

7. What is the shape of a muscle cell, and what name is given to it in consequence?

8. Voluntary muscle is sometimes spoken of as striated. Do you see why? What kind of muscle cell is shown in Fig. 5?

9. How are muscles attached to the bone? What advantage is there in the attachment by means of tendons?

If possible obtain a frog that has been recently killed. Remove the skin from the hind leg and find the muscle forming the calf of the leg and its opposing, or antagonistic, muscle. What does each do? Note that although the larger muscle forms the outline and gives shape to the calf, it is not attached to the bones of this joint. Try to find the upper attachment (origin) on the femur and lower attachment (insertion) on the ankle. At which end is the tendon?

10. When one uses a crowbar and a block to pry up a rock or other object, he is making use of a simple machine called a lever. The block is called the fulcrum, the portion of crowbar upon which the strength is exerted is the power arm, and the portion of the bar on the other side of the fulcrum is the weight arm. The law of the lever is: $\text{weight} \times \text{weight arm} = \text{power} \times \text{power arm}$. Thus, if the power arm is 10 feet and the weight arm 1 foot, a force of 1 pound can lift a weight of 10 pounds. Another form of lever is a pair of scales for weighing. Here the power arm and weight arm are equal. What is the principle involved in weighing a pound of tea, for example?

There are three classes of levers: the first class has the fulcrum between the weight and the power; the second has the weight between the fulcrum and the power; the third has the power applied between the fulcrum and the weight. In the human body are found examples of all classes of levers. The joints are the fulcrums, and the muscles furnish the power.

Examine Fig. 39. What class of levers is illustrated when the arm is bent by the biceps? State exactly what represents the power arm; the weight arm. In this case is the advantage gained the ability to raise a weight with little exertion, or a great range of motion with the application of considerable muscular energy?

Study the motion of other joints and determine the kinds of levers illustrated.

11. How is the body maintained erect? State the function of the "erectors of the spine." What muscles are antagonistic? State the functions of the psoas muscles.

The muscles at the back and front of the thighs and the lower legs keep the trunk balanced on the legs.

12. Does the action of muscles always result in the movement of some joint?

13. Locate on your body, according to the following directions, some of the common muscles and give their functions. See Fig. 34 to determine the names of the muscles.

(a) Place your hand on your neck below your jaw and turn your head.

(b) Place your hand at the back of your neck and nod your head.

(c) Place your hand on your chest just below the collar bone. Move the arm horizontally on a level with the shoulder.

(d) Place your hand on one shoulder. Allow the arm to hang at the side, then raise it to a horizontal position.

(e) "Try your muscle" in your upper arm.

(f) Grasp your forearm tightly and open and close the fingers.

(g) Place the hand on the back and raise and lower the shoulder.

(h) Place one hand on the front and the other on the back of the lower leg and move the foot.

The muscles of the thigh are somewhat too complex to be studied in this manner. However, you might try to locate the biceps femoris and the sartorius.

LESSON 5

HYGIENE OF SKELETON AND MUSCLES

Read pp. 53-57 and 73-75.

1. Why is it important to acquire a correct carriage in youth? How may one do this?

2. How does a broken bone mend? What is meant by "setting a bone"? What precaution should be observed in moving a person with a broken arm or leg?

3. What is a dislocation; a sprain? State some things to be observed in the treatment of a dislocation or sprain.

4. What is meant by physical exercise? State three important facts about exercise.

5. State how exercise is beneficial: (a) to the muscles (what is the effect of not using a muscle for some time?); (b) to the circulation; (c) to respiration; (d) to digestion.

6. Do muscles get tired? How do they show that they are tired? Have such muscles lost the power to contract?

There are reasons for believing that fatigue is due to a condition of the nervous system rather than of the muscles, because in case of involuntary actions, as in St. Vitus dance, there seems to be no fatigue.

7. Under what conditions may exercise become harmful?

A football team must undergo a long training before undertaking the severe strain of its hard games. Why?

8. What is sleep? What is its value? How much sleep does a person need?

9. What are the advantages in an athletic game like golf? What is the purpose of a gymnasium?

10. What, in general, is the effect of tobacco and alcohol upon the cells of the skeleton and the muscles? What is the practice as to the use of alcoholic beverages and tobacco in the case of teams training for athletic contests?

Some of the preceding questions are not answered directly in your book. In such cases you are expected to do a little investigating. Ask some physician or physical director to help you answer the questions.

EXAMINATION

1. Make a sketch of a cell. Label the cytoplasm and the nucleus. Do not make the sketch too small.
2. Can an animal live without organs? State how you know.
3. How many and what tissues would you find in a voluntary muscle?
4. Explain the appearance of one-celled animals in a glass of water containing decaying organic matter.
5. How do we know that these one-celled animals are alive? How do they swim about?
6. How may the cells of the human body be compared to a community of people?
7. What is man's place in the animal kingdom?
8. A person is said to be shorter in the evening than in the morning. How may this be explained?
9. Why are some children bowlegged?
10. Why is it more serious for an old person to break a bone than for a child?
11. Assuming that the radius is 14 inches and that the biceps is inserted 2 inches from the end, how much force must the biceps muscle exert to raise a weight of 5 pounds by bending the elbow?
12. Where in the human body do we find a lever of the first class?
13. Why does a person instantly fall down when given a severe blow on the head?
14. Name an organ in the human body that has involuntary muscles. Why is this a wise provision?
15. What muscles would you use in climbing a rope hand over hand?

SEND YOUR EXAMINATION TO THE SCHOOL

PART III

DIGESTION

LESSON 6

FOODS

Read Chapters VII and X.

1. State the three reasons why food is necessary to the human body. How would you define the term "food"?

Energy is that which gives capacity to do work. It cannot be created or destroyed, but one form of energy can be changed into another. The energy needed by the body is obtained through the oxidation of the food. (See p. 160.) Read carefully pp. 285 and 286 in the Appendix.

2. Accepting the fact that alcohol can, to a certain extent, be oxidized by the body and thus furnish energy, why may it not be considered a food? (See p. 210.)

3. Just what is it to "be hungry"?

Sometimes a person becomes so absorbed in a piece of work that the mealtime passes and he has not noticed that he has not eaten. How long can a person live without eating? What would happen if we did not have the sensation of hunger?

4. Read carefully pp. 79-82. Write good definitions of the terms "atom," "molecule," "element," and "compound."

5. When a chemist writes the symbol H_2O , what does he mean? How many atoms are there in this molecule?

Hydrogen is a gas and oxygen is a gas. When united in the above proportions at the ordinary temperature, the result is water. If you heat water until it changes to the gaseous state (steam), is it still composed of the same atoms in the same proportions? If possible, turn to some book on chemistry and read about the electrolysis of water. By means of certain apparatus an electric current may be passed through two tubes of water. The water in these tubes is at first at the same level. After some hours there is space apparently above the water in each tube, but this "space" is twice as great in one tube as in the other. A glowing match placed in the latter bursts into flame, showing that what apparently was a vacuum, in reality contained

oxygen. If a match is applied to the other, it burns like illuminating gas, showing the presence of hydrogen. What has the electric current done?

6. Name the three groups of organic foods.

By "organic" food we mean food derived from animals or plants.

7. What foods are included under the term carbohydrates? Name articles of diet which furnish carbohydrates.

8. What is the chief value of carbohydrates and fats?

9. What are proteids? What is their function?

These are sometimes spoken of as nitrogenous foods. Why?

10. What articles of diet are especially useful as sources of proteids?

11. What are the principal inorganic foods? Why should green vegetables form part of our diet?

12. What are vitamins? (See Appendix, p. 292.)

13. Plants which contain the green coloring matter called chlorophyll can, under the influence of light, use the carbon dioxide of the air and combine it with water and manufacture carbohydrates, which they use as food. Can animals do this? Suppose all green plants should disappear from the earth, how would this affect animal life?

Keep in mind that the animals whose flesh we eat are themselves plant eating (herbivorous).

14. What determines the amount of food needed by the body? (See p. 124; also Appendix, p. 286.) Why is it best to have a mixed diet?

15. State at least three reasons for cooking food.

LESSON 7

PROCESS OF DIGESTION

Read Chapters VIII and IX.

Try the following experiment. Obtain at a drug store a little Fehling's solution, a little iodine solution, and five test tubes. Fill one test tube one-third full of water, add a little starch, and boil. Pour a few drops into a saucer and add one drop of the iodine solution. What color does the starch solution now have? Into a

second tube put some water in which a raisin has been soaking (grape sugar). Add some Fehling's solution and boil. In a third tube pour a little of the starch solution and about four times its volume of saliva, and place the tube in a tumbler of hot water for half an hour. Then pour a little into the fourth and a little into the fifth tube. Test one with iodine and the other with Fehling's solution. What has the saliva done to the starch solution?

1. Give a good definition of digestion. What kind of foods must be digested? Why?
2. Name the divisions of the digestive system.
3. What is a gland? (See Fig. 47.)
4. Describe the process of secretion.
5. What is an enzyme?
6. Name five important digestive glands in the human body.
7. What digestive glands are in the mouth? What is digested there?
8. What is mastication and what is its purpose?
9. Study Fig. 52. Describe the structure of a tooth.
10. Distinguish between temporary and permanent teeth. How many teeth are in each set?
11. What are the three groups of teeth according to shape and function?

By examination of the animals or of pictures, see what teeth are most prominent in dogs, cats, and other carnivorous, or flesh-eating, animals; in rabbits, mice, and other gnawing animals; in cattle and other grazing animals. What is there unusual about the incisors in the upper jaw of cattle?

12. Describe the stomach.
13. Study Fig. 49. Name the layers in the wall of the stomach.
14. What glands are found in the stomach? What is their function?
15. What is the purpose of the acid secreted by the gastric glands?
16. What is the function of the muscles in the coat of the stomach?
17. Study Fig. 51. What glands are found in the walls of the small intestine?

18. What two glands open into the small intestine?
 19. What is the function of the pancreas?
 20. What substance does the liver secrete? What is the function of this substance?
 21. What part of the nervous system chiefly controls the digestive system?
 22. In what two forms is food stored in the body?
 23. Where is sugar stored in the body? Where is fat stored?
- Hibernation is a habit peculiar to animals of cold regions. Another habit is to migrate to warmer regions as in the case of birds. What do you think is the purpose of these habits?
24. How are the indigestible materials in our foods eliminated from the body. (See Appendix, p. 287.)

The walls of plant cells are composed of cellulose (similar to cotton fibers), which has no food value because it is indigestible. Why should this indigestible material be removed?

PART IV

RESPIRATION AND CIRCULATION

LESSON 8

RESPIRATION

Read Chapters XII and XIII.

1. What is respiration?
2. What is the source of oxygen?
3. What is the atmosphere? What gases compose the atmosphere and in what proportions? What three impurities are in the air?
4. Study Fig. 84. Describe the structure of the lungs.
5. What is the relation of the trachea, bronchial tubes, and air sacs?
6. Where is the larynx? Of what are its walls composed?
7. What surrounds the lungs? Why? In what other way are the lungs protected?
8. How does air get into the lungs?
9. What term is used to describe the taking of air into the lungs?

10. Show how the action of the diaphragm and ribs accomplishes inspiration.

11. Trace the course of air from the outside into the air sacs of the lungs, naming in order each region through which it passes. How are the nostrils especially well fitted for their work? What is the uvula?

12. What is the purpose of the epiglottis?

Read carefully the fine print at the bottom of p. 165.

13. How is expiration accomplished?

14. State how the air gets out of the lungs into the blood.

15. What passes out of the blood into the lungs?

16. What is the purpose of the mucous and the cilia in the respiratory tract?

17. Describe the vocal cords.

18. How is sound produced?

LESSON 9

CIRCULATION

Read Chapter XI.

1. What are the chief purposes of circulation?

Keep in mind that food is prepared in one part of the body and that respiration occurs in another. The food and oxygen, however, are needed by *all* the cells in all parts of the body. There must therefore be some means of distribution, and the circulatory system is well adapted for this purpose. The same principle applies to the elimination of waste products. Circulation of blood in the human body was discovered by Harvey, an Englishman, in the sixteenth century.

2. Name the three divisions of the circulatory system.

3. Of what two things is blood made up?

4. Contrast the red and the white corpuscles as to structure and number. State the function of each.

5. What is the purpose of the plasma?

If blood is exposed to the air it soon forms a jelly-like mass and is said to clot. Under the microscope this clot is seen to be composed of a tangled mass of delicate fibers called fibrin in which the corpuscles are entangled. After a while the clot separates from a yellow liquid portion, called the serum.

Wash the hand thoroughly and prick the end of the finger with a new needle, having first sterilized the needle by holding it in a flame for a short time. Place a drop of blood on a small white butter dish and you can observe the formation of the clot.

6. Study Figs. 64 and 70. Describe the heart, noting its size, the kind of wall, and the number of cavities.

7. What is the heart doing when it beats?

Place your hand on your chest slightly to the left of the sternum, in the region of the fifth rib, and feel your heart beat. Does the heart ever stop beating?

8. Why does the blood always flow in the same direction?

9. Describe the two kinds of valves of the heart and state where each is located.

10. What is the pericardium?

11. What are the two kinds of blood vessels? How are they connected so as to make circulation complete?

12. How is an artery distinguished from a vein?

Don't make the mistake of assuming that arteries always carry pure, and veins impure, blood.

13. In general, which are nearer the surface, arteries or veins? Why?

14. Contrast the structure of the walls of arteries, veins, and capillaries. Why do some veins have valves?

15. What is your pulse?

To take your pulse, turn the palm of your left hand up and press the tip of the middle finger of your right hand on the wrist just to the left of the large cords (tendons).

16. Trace without going into detail the general course of circulation, beginning with the left ventricle. (Study carefully Fig. 65.) How long does this take?

17. What is lymph? Where is it found? What are its two functions?

18. Why are special lymphatic vessels necessary?

19. Study Fig. 66. Note the lymph nodes and the thoracic duct. How does the lymph get back into the blood vessels?

20. What are lymph nodes? What are their two functions?

21. Study Fig. 51. Locate the villi. Turn to Fig. 76. How do sugar and proteins get into the blood?

22. How do fats get into the blood?

23. How does the nervous system control the circulation? What regulates the amount of blood sent to different parts of the body?

LESSON 10

HYGIENE OF RESPIRATION AND CIRCULATION

Read Chapters X and XIII.

1. What is indigestion? State some of the causes of indigestion under the following heads: (a) manner of eating; (b) time of eating; (c) kind of food; (d) condition of the body; (e) things which affect the nervous system adversely.

2. What are the three most common mistakes made in selecting the diet?

3. What are the standard foods, that is, the foods that should form the basis of the meals of the average healthy person? To what extent is it safe to follow the cravings of the appetite?

4. What are condiments? What is their value?

5. What is the effect of tea and coffee? State why these are not good for young people while they are growing.

6. What is meant by ventilation? Under what conditions is it necessary?

Ventilation and heating are usually accomplished by the same system. Study the method of heating and ventilation in your own home and then visit some public building, that is, a school or theater and observe the method of heating and ventilation there.

7. What three things should characterize the air that is introduced into a room in ventilation? What is the proper temperature to keep a room in which one is working; sleeping?

8. How does tight clothing interfere with the respiratory movements? What is the value of deep breathing?

9. How does tobacco injure the heart; the lungs?

10. What is the effect of alcohol on the process of digestion; the action of the liver; the action of the heart?

EXAMINATION

1. State to what class of foods each of the following belongs, also its value in the diet: eggs, milk, oatmeal, rice, honey, water.

2. Why is bread and butter said to be a perfect food?

3. In what three regions of the alimentary canal does digestion actually take place? Could a person live if his stomach were removed? Give the reasons why you think as you do.

4. Some persons (vegetarians) believe we should eat no meat. Does the structure and arrangement of the teeth support or oppose this belief? Explain.

5. What is illustrated by the fact that one's "mouth waters" at the sight of food? What does the expression mean?

6. What is the dietetic value of bran muffins?

7. Explain what happens when one chokes.

8. Explain why on a cold day one exercises to keep warm.

9. When you cut your finger and the blood flows from a vein it is red. Why is this true when venous blood is purplish?

10. Why is the clotting of blood of great value? Why does not blood from the larger arteries clot as easily as that from the veins and small arteries?

11. Why should we not breathe through our mouths?

12. What is the purpose of clothing? What things should regulate its use?

13. For what purpose does a doctor use a stethoscope?

14. Describe the method of heating and ventilation in your home. What defects do you find?

15. Describe the heating and ventilating system of some public building. What methods do you find for changing the air; for purifying the air?

SEND YOUR EXAMINATION TO THE SCHOOL

PART V

EXCRETION

LESSON 11

KIDNEYS AND LIVER

Read Chapter XIV.

1. What is meant by the term "excretion"?

2. When food is oxidized what waste products are thrown off in the process?

Under the topic "Respiration" we have seen how carbon dioxid is eliminated from the body. The other wastes are thrown off through the skin and the kidneys.

3. What is the size of the kidney; the shape; the location?
4. Study Fig. 91. Of what are the kidneys chiefly composed?
5. Describe the renal capsule.
6. State just how wastes escape from the blood into the kidneys.
7. What is urine? How does this escape from the kidneys?

Where is it temporarily stored?

Urine consists of about 96 per cent water and 4 per cent solids. The latter is chiefly urea and uric acid, salts, and coloring matter. Sometimes albumin is found in urine, indicating diseased kidneys, as in Bright's disease; and sometimes sugar is found, indicating diabetes. That is why the doctor always examines the urine when examining a person for life insurance.

Study Fig. 66. Find the kidneys and then find the descending aorta.

8. What is the position of the aorta with reference to the kidneys? What branches does it give off? Find the ascending vena cava. What branches do you see, and what are their positions with reference to the two branches of the aorta?

9. What is the effect of alcohol on the kidneys?

Refer to Fig. 65. Note that the blood from the intestine goes to the liver, and not directly to the heart. Sometimes poisonous substances (the result of fermentations of the food) that have been absorbed are in this blood, and the liver in some way destroys them.

10. How is the blood thus purified returned to the heart?

11. Why may the liver be considered one of the excretory organs?

12. See p. 102. What is the effect of alcohol on the liver?

LESSON 12

THE SKIN

Read Chapter XV.

1. Study Fig. 93 carefully. What are the three regions indicated in the figure? Which of these belong to the skin?

2. What is the general function of the epidermis? Where is it especially thick? Name three things caused by abnormal thickening of the epidermis.

3. Of what is the dermis composed? What are the papillae?

See Fig. 95. Examine the tips of your fingers and note the ridges. If the fingers are smeared with ink and then pressed on a sheet of paper, an impression of these ridges is made. It has been found that the arrangement of these ridges is practically never the same in any two persons. That is why finger prints are used so frequently in the detection of criminals.

4. Describe a sweat gland. Where are the sweat glands located?

5. What is perspiration? Under what conditions does the amount secreted vary?

Perspiration, or sweat, is not pure water. You may have noted its salty taste (due to the presence of a small quantity of common salt), and there is always a small amount of urea. Anything that checks the action of the kidneys increases the amount of this latter substance in perspiration.

6. Read carefully what the textbook says about the body heat, pp. 197-199. What is the normal temperature of the human body?

Obtain a clinical thermometer and place it under your tongue about two minutes and then remove and read. Be sure the thermometer is shaken so that it reads about 94° or 95° before using. The thermometer should be washed in cold water before and after it is used.

7. What is meant by fever? What temperature is considered a sign of danger?

8. Refer to Fig. 93. Locate the nerves. Where do they end? What is the name given to the structure found at the end of the nerves?

9. Study Fig. 96. Describe the structure of a hair. What glands are associated with it? What is their function?

10. How does a hair grow?

11. Name some uses of hair.

In some of the lower animals the thick covering of hair and especially fine hair or fur keeps the animal warm.

12. In what regions do we find the larger number of our important fur-bearing animals?

13. Describe the formation and the growth of the nails. Name two functions of the finger nails.

In many of the lower animals the nail varies considerably with the habits of the animal. Contrast the short heavy nails of the dog with the sharp, curved, retractile claws of the cat. The hoof of a horse is the greatly enlarged nail of its single finger or toe.

14. To what is the color of the skin due? Explain how a person tans. What are freckles?

15. What are the four general functions of the skin?

LESSON 13

HYGIENE OF THE SKIN

Read pp. 200-208.

1. Why should a person drink plenty of water?

2. What is the physiological purpose of bathing?

3. What is the effect of a cold bath?

4. What precautions should be observed in taking cold baths?

When should such baths be taken?

5. What is the effect of a warm bath? When should such a bath be taken?

6. What precautions should be taken about bathing just before or after eating? Why?

7. Describe some of the dangers of overheated and underheated rooms.

8. What is the purpose of clothing? Contrast the effect of woolen clothing and that of cotton clothing.

9. What are the bad effects of wet clothing?

10. Why should one keep his feet dry?

If one gets his feet wet, he should keep moving until he can get to a place where he can change his shoes and stockings.

11. Name some of the important points in the treatment of the hair and the nails.

PART VI

NERVOUS SYSTEM

LESSON 14

CENTRAL NERVOUS SYSTEM

Read Chapters III, XVI, and XVII.

1. What is included under the term "central nervous system"? What are the three important divisions of the brain? See Fig. 13.

2. What name is given to the elements of which the nervous system is composed? What are the two divisions of such an element?

You must not think of nerve cells and nerve fibers as separate things. The nervous system is a complex arrangement of associated neurons, and each neuron is really a nerve cell that is more or less branched. See Fig. 97 and also turn back and look at Fig. 5. One branch is very much longer than the others and is called the fiber. The names "cell" and "fiber" were given before scientists had discovered the real connection between the two parts of the neuron. Just what is meant by efferent and afferent fibers?

The plan of the nervous system is as follows: Certain neurons are grouped together at certain parts of the surface of the body and are especially adapted to receive or to be affected by certain forms of stimulus, such as light, sound, etc. These groups of neurons are called sense organs. Their fibers carry impulses to the central nervous system as a result of the stimulation they have received. In other groups of neurons the cell portion is in the central nervous system; the fibers of these neurons reach out to and end in some muscle or gland, carrying to it the nerve impulses which result in action. See Fig. 101.

3. Just what is meant by the term "reflex action"?

4. Why are reflex actions said to be involuntary?

5. What are the two regions of the central nervous system that control reflex actions?

6. What are acquired reflexes?

7. What advantages can you see in having so many actions of the body reflexes?

8. In what part of the brain do voluntary acts originate?
9. Why could you not perform voluntary acts if the medulla were injured?
10. What would be the effect of an injury to the spinal cord on the ability to perform voluntary acts?
11. What is thought to be the function of the cerebellum?
12. What is a sensation? In what part of the brain do sensations occur?
13. What do you think is the purpose of sensations?
14. What is your idea of the meaning of the term "intelligence"; of "mind"?
15. Could one learn anything if he had no brain?
16. Just what part of the brain is supposed to be the "seat of the intellect"?
17. In what part of the brain do we reason; remember things?

The study of the functions of the brain is too difficult to be considered in a course in elementary physiology. Scientists have spent many years in the study of the brain and its actions and in making experiments, and this has led to the development of a very important science called psychology. Based upon this we have an associated science, that of education, or pedagogy.

18. Study Figs. 99 and 100. Also turn back and look at Fig. 13. How is the brain protected?
19. Describe the membranes surrounding the brain.
20. Into what is the cerebrum divided?
21. What is peculiar about the surface of the cerebrum?
22. What is a nerve? What is the difference between a nerve and a nerve fiber? Can the same nerve contain both afferent and efferent fibers?
23. What are the cranial nerves? How many are there?
24. What are the spinal nerves? How many are there?
25. Describe the method of attachment of the spinal nerves to the spinal cord.
26. Summarize what you have gone over by answering the following questions:
 - (a) What is the general function of the nervous system?
 - (b) What are the functions of the cerebrum?
 - (c) What are the functions of the cerebellum?

- (d) What are the functions of the medulla?
- (e) What are the functions of the spinal cord?
- (f) How are all the various parts of this complex nervous system with its varied functions made to work together so well?

LESSON 15

SENSE ORGANS

Read Chapters XIX and XX.

1. When one has a sensation, where does it really take place?
What is a sense organ?

2. What are the five special senses?

The act of seeing an object is a complex operation composed of a combination of sensations and usually associated with some act of reasoning by the mind. One has to be trained to see, and this is one of the purposes in studying such sciences as zoölogy and botany. It is the same in the case of hearing, etc.

3. What is the sense organ in the case of touch?

4. Name some of the things we feel.

5. How is the sense of touch different from the sense of pain? Press a pencil point lightly on the back of the hand, then press down hard. Note the difference in the feeling.

From experience we have learned to associate pain with the extremity from which the stimulation arises. Thus a person who has had a foot or hand amputated will often maintain that the foot or hand still hurts.

6. Are all parts of the skin equally sensitive?

7. Where do the nerves of taste end?

8. Describe the structure of a taste bud.

9. In what condition must a substance be before it can be tasted?

10. Describe the appearance and distribution of the olfactory cells.

11. What is an odor?

12. How do we detect odors?

13. What is the organ of hearing? What are its three divisions?

14. What is the purpose of the external ear? How is its shape well fitted for this purpose?

Compare the shape of the external ear with an ear trumpet. What is at the inner end of the external ear?

15. What structures are found in the middle ear? How does this region communicate with the mouth?

Examine a drum and find the opening in the side. Hold your finger over this and hit the drum with a drumstick. What do you observe?

16. Describe the inner ear.

17. Explain how we hear sounds.

18. What function has the ear besides that of hearing?

19. What is the shape of the eye?

20. State the structures associated with the eye and tell the purpose of each.

21. What are the two cavities in the eye? What divides them? What does each contain?

22. Describe the three coats of the eye. What is the cornea? What is it ordinarily called?

23. Explain just how we see objects.

24. When using field or opera glasses, we have to focus them, that is, we have to adjust them differently according to whether the objects are near or at a distance. How does the eye make a similar adjustment?

25. How is the amount of light entering the eye regulated? What is the pupil of the eye? Why is this always black?

26. Without moving your head, determine your range of vision, that is, how far to the right and the left can you see things by moving your eyes? How is this wide range of vision possible?

27. Could a person live if one or more of the special sense organs were injured or useless? Give some facts to support your statement. When one sense organ is not properly developed, what is the effect on the other sense organs?

28. What is the result of inflammation of the mucous membrane of the nose? Name two causes of such inflammation.

29. Name three ways in which the ear may be injured. What is ear wax? What is its purpose? What care should be observed in removing objects from the ear?

30. When is a person near-sighted; far-sighted? How may the defect be corrected?

31. What is astigmatism? When the eye is thus diseased, how do objects appear?

Visit an oculist and observe the card he uses in testing the eyes. If you can obtain such a card, test your own eyes.

32. Name five things that should be observed in the care of the eyes.

33. State the injurious effects of alcohol and tobacco to the brain and sense organs.

EXAMINATION

1. What is the difference between secretion and excretion? Name four places in the human body where excretion takes place and state what is excreted in each case.

2. Explain the desire to drink more water in summer than in winter.

3. The skin of persons living in hot countries is usually darker than that of other persons. What causes the difference? What purpose of the pigment cells is indicated by this fact?

4. We know we can wash our hands cleaner with the aid of soap than without. Why is this so? In what way may soap be injurious to the skin? Explain the cause of the chapping of the skin, and state under what conditions it occurs.

5. When you pinch your finger, a blister is often formed. Using your knowledge of the structure of the skin, account for this fact.

6. The surface of a frog's brain is smooth. What fact is suggested by this?

7. When you touch an earthworm, it wriggles violently. Is this because you hurt it? Explain. What is the advantage of the sense of pain?

8. Although you *look* at an object with two eyes you *see* only one object. How can you explain this fact?

9. A fish has neither eyelids nor tear glands. Show why they are not necessary.

10. To what do you refer when you say a person has blue eyes?

11. Which would be the more dangerous wound for a soldier

to receive, a wound at the base of the brain or at the lower part of the spinal cord? Why?

12. Why is sleep necessary?

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PART VII

DISEASE GERMS

LESSON 16

BACTERIA

Read Chapters III-VI, Part I.

1. Why is a knowledge of disease germs important?
2. What are disease germs?
3. Name the three principal ways in which germs enter the body.
4. How do germs cause disease in the human body?
5. Name the two principal ways in which the body combats disease germs.
6. Name five ways that germ diseases can be prevented.

It should be kept in mind that the entrance of germs into the body is not always followed by disease. A healthy, sound body can probably counteract the effect of the germs in a large majority of the cases. It is only when the resistance of the body is impaired by poor health, or when some organ has become weakened, or germs are present in unusually large numbers, that these enemies cannot be combated.

7. What are bacteria?

Place a bit of meat in a jar of water and leave it exposed to the air. Soon it acquires an offensive odor and a scum forms on the surface. This is caused by some form of bacteria, as is all decay. To see the shapes of bacteria, Fig. 13, one would need a powerful microscope.

8. What is the size of bacteria?
9. What are the three principal shapes of bacteria?
10. What is the method and rate of multiplication of bacteria?

11. What is the distribution of bacteria?

12. Under what conditions do bacteria produce spores? Why?

The spores have a very thick wall; this explains their resistance to the action of heat, even boiling.

13. What are the three groups of bacteria according to their effect?

We should avoid thinking of bacteria as a group of harmful organisms. Those that cause disease (pathogenic) are few, compared to the group as a whole. On the other hand, many of the processes in nature and many commercial operations depend upon the action of these tiny organisms. Thus, plants like clover renew worn-out soil, and thus increase its fertility, because they have in their roots bacteria which can take up and utilize the nitrogen of the air.

Bacteria are plants, and the conditions for their growth and development are quite similar to those for plants called fungi, that is, mold on bread or jelly. Some are parasites (living on or in the bodies of living organisms), others are saprophytes (living on dead organic substance).

LESSON 17

GERMS THAT ENTER BODY THROUGH SKIN

Read Chapters VII and VIII.

1. What is pus? What are pus-forming bacteria? How abundant are they?

2. Name some of the things pus-forming bacteria do: (a) on the skin; (b) in the throat; (c) in the digestive tract; (d) when distributed throughout the body.

3. What causes a scratch or other wound to become infected? Where did the germs come from?

4. How should a wound be treated to prevent infection if made by a sharp instrument; if made by a dull, rough, or unclean object?

5. What is the tetanus germ? Where does it live? How does it get into the human body?

6. What is the strength of the toxin produced by the tetanus germ? What is its effect upon the body?

7. What is the source of the tetanus antitoxin? When is it most valuable? How is it administered?

You will get a good idea of the value of this antitoxin if you will read some account of how the surgeons treated wounds in the recent war.

8. What peculiar characteristic has the tetanus germ in relation to air?

9. What does the knowledge of the germs studied in this lesson show us about the value of personal cleanliness?

PART VIII

DISEASE GERMS

LESSON 18.

DIPHTHERIA

Read Chapters IX and X.

1. Why are the air passages especially favorable for the growth of bacteria?

2. In what part of the body is the germ of diphtheria usually found? How does it get there? Where does it come from?

3. Why is diphtheria a hard disease to control? What precaution is desirable to prevent it from becoming epidemic?

It is unwise to neglect a sore throat, especially if it is accompanied by fever. A person apparently well, who has the disease germs in his throat, is called a "carrier." Read the fine print at the bottom of p. 39 in the textbook.

4. What are the strength and the effect of the diphtheria toxin?

5. From what is diphtheria antitoxin obtained? When should it be used? How successful has it proved to be?

Write to your city health department and obtain information as to the effect of its use in your city.

6. What is influenza? Where do the germs grow?

7. How is influenza spread? (See Fig. 35.)

Recall some of the precautions and regulations ordered by the health authorities during an epidemic of influenza.

8. What is a cold? How do we "catch cold"? Is it probable that we can catch cold if the air is pure and not laden with dust? Explain.

9. What is the cause of bronchitis; of catarrh?

10. What is the cause of whooping cough?

LESSON 19

TUBERCULOSIS AND PNEUMONIA

Read Chapters X, XIII, XIV, and XV.

1. What organs are affected in case of pneumonia? What are some of the characteristics of the disease? How are the lungs affected; the heart?

2. What causes pneumonia? How does the germ get into the body?

3. How can pneumonia best be prevented?

4. What is usually meant by tuberculosis?

Read carefully what the textbook says about the cost of tuberculosis. Try to obtain from your health board literature dealing with this disease.

5. How do the germs enter the lungs from the air (what precautions does this suggest?); from food?

6. In what two ways may milk be rendered safe?

Obtain from the library some book on agriculture and look up the so-called tuberculin test.

It should be kept in mind that consumption in the early stages *is curable*. (See p. 61 and Fig. 44.) What is the advantage of rest in the case of a person with tuberculosis? What should be the character of his food? What effect has outdoor life; climate?

7. What are the facts about consumption being inherited?

8. Write a brief statement of the progress that has been made in the fight to stamp out this disease.

9. Why have many states established sanatoria for consumption?

10. What is the relation between the use of alcohol and consumption?

Read carefully Chapter XXI.

EXAMINATION

1. State clearly the difference between disease germs and bacteria.

2. If a piece of meat is placed in a jar of water exposed to the air, bacteria appear. How can you account for this? Are bacteria the cause or the result of decay?

3. Tell how the statement "an ounce of prevention is worth a pound of cure" is especially true in the case of germ diseases.

4. State in what cases and for what reasons it is especially desirable to quarantine a patient.

5. What is the scientific basis of the "Sane Fourth" laws?

6. State clearly just why "dry sweeping" is considered unsafe?

7. If climate has no effect on consumption why do so many persons go to Arizona to be cured of the disease?

8. What is meant by an epidemic? Would a case of blood poisoning be apt to start an epidemic? Why so or why not?

9. What is an antitoxin? State clearly the theory upon which its use is based.

10. What do you think is the most valuable thing to be learned from your study of disease germs in Parts VII and VIII?

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PART IX

DISEASE GERMS

LESSON 20

MALARIA

Read Chapters XXI, XXII, XXIII, and XXIV.

1. Is the malarial germ a bacterial or an animal germ? What part of the body does it attack? What is its effect? What is the cause of the chill; the fever?

2. When a mosquito "bites" a person that has malaria what happens?

A mosquito does not really bite. It has a sharp piercing mouth part for piercing the skin. The mouth part is hollow so that the insect can suck the blood of its victim.

3. After a period of development in the stomach of the mosquito the germ produces other germs which make their way into the insect's salivary gland. State clearly how this latter germ may be introduced into the human body.

4. State how we know that malaria cannot be spread by any other method.

5. State the two most effective methods of preventing malaria.

6. What other disease is spread in the same way as malaria?

7. In what kinds of places do mosquitoes breed?

8. State briefly the life history of the mosquito.

9. What species of mosquitoes are spreaders of disease? How can the malaria mosquito be recognized?

Mosquitoes belong to the order *Diptera*, or two-winged insects. See Fig. 81. This order also includes the common flies.

10. Show how to prevent the breeding of mosquitoes (a) in the case of receptacles that collect or contain water; (b) in the case of ditches and swamps; (c) in the case of larger bodies of water.

11. State some cases where these preventive measures have had some very important results.

LESSON 21

SMALLPOX AND OTHER PROTOZOAN DISEASES

Read Chapters XXV and XXVI.

1. What is the germ of smallpox?

2. How is the germ scattered? What precaution is especially important?

Read the story "Lady Eleanore's Mantle" in Hawthorne's "Twice Told Tales."

3. What is the theory of vaccination? How effective is it?

4. Who discovered vaccination? When?

5. How long does vaccination protect?

When a person has had a disease, he is in many cases protected from a second attack and is said to be immune. At the time of the Spanish-American war a whole regiment of yellow-fever immunes was raised for service in Cuba.

6. What is hydrophobia? What is the only way in which a dog can contract rabies? How can this disease best be prevented? Can it be cured?
7. Describe the Pasteur treatment. How long is it effective?
8. State the cause and the source of infection with rabies.
9. Name two diseases besides those already considered the germs of which are supposed to be animal germs.
10. Why should patients in these cases be quarantined?

LESSON 22

TYPHOID

Read Chapters XXIX, XVII, XVIII, XIX, and XX.

1. Describe the typhoid germ. What organs does it chiefly attack?
2. Under what conditions can this germ live outside the human body?
3. Name four ways in which typhoid can be most readily controlled.
4. Name the four stages in the development of the housefly. See Fig. 96 and p. 147. Where are the eggs laid? How long before the egg develops into a maggot? How long before the maggot becomes a fly?

Place a piece of meat in a dish where flies can have access to it. Watch for the development of the maggots on it and then burn it. Since the maggots are in this case scavengers they may be considered useful. The fly is harmful when in the adult stage.

There are several other kinds of flies found in the house besides the true housefly. The most common are the large blue-bottle, the greenish blowfly, and the stable fly—the fly that bites and is so troublesome on sultry days.

5. Why does a fly so readily spread disease? See Fig. 17. What is the best method of exterminating the fly?
6. Name two diseases caused by germs related to the typhoid germ.
7. Name two instances where purification of the water supply reduced the typhoid of a community.
8. How do typhoid germs get into drinking water?

9. Name some kinds of water that are unsafe to drink.
10. How can drinking water be most easily rendered safe?
11. How do typhoid germs get into or on food?
12. Why should milk bottles be washed before they are opened?
13. How can milk best be rendered safe?

There are other diseases spread by milk besides typhoid.

Re-read carefully Chapter XXX.

14. Name some of the more common parasitic worms.
15. What is the one thing necessary to prevent the human body from being infected with these worms?

Re-read carefully Chapter XXVII.

PART X

SANITATION

LESSON 23

PERSONAL SANITATION

Read Chapters XXVIII, XXXI, and XXXII.

1. Define the term "sanitation." See p. 143.
2. What is the source of disease germs? See p. 8.
3. What is the effect of light on disease germs? What is the effect of drying? What is the effect of heat?

Try this experiment. Take four pieces of bread and place each in a saucer, cover with a tumbler, and number 1, 2, 3, and 4. Place No. 1 in the light. Moisten No. 2 and place it also in the light. Treat Nos. 3 and 4 in the same way, but place them in the dark. Watch for the development of mold. All the saucers should be kept in a somewhat warm place.

4. What is chemical disinfection?

Re-read pp. 159-162.

5. What is meant by fumigation? What is used for this purpose?

6. Re-read Chapter XXXII. Name some unhygienic habits and state why each is dangerous.

7. Turn to Part II, Chapter XVIII. What is alcohol? What are the common alcoholic drinks? How much alcohol do they contain?

8. How does the use of alcoholic drinks affect length of life? Name some other bad effects of their use.

9. What conclusions can be made as to the use of alcoholic drinks. How would you answer the argument that it is the excessive use of alcohol that is harmful and that its use in moderation does not do much harm?

LESSON 24

PUBLIC SANITATION

Read Chapters XXXIII, XXXIV, and XXXV.

1. Name three reasons why it is wise and necessary for the government to undertake the work of public sanitation.

2. What department of your city cares for its health? Who is your chief health officer?

3. Name at least four things the health department does in order to protect the health of the community.

4. What is one's civic duty in case of a contagious disease in his home?

5. What does the law require the doctor to do in cases of contagious diseases which he is treating?

6. What does the U.S. government do to protect you from disease which may be contracted from eating infected meat?

7. What is the source of the drinking water in your city?

8. What is the method of sewage disposal in your city?

9. Why is it a good investment for a city to establish parks and playgrounds?

10. What is an isolation hospital?

EXAMINATION

1. Write a brief statement showing the relation between insects and disease.

2. The success of the United States in completing the Panama Canal was due to sanitation quite as much as to engineering. Explain this.

3. What is the basis of fact in the popular notion that marshy regions are malarial?

4. How does the theory on which the antitoxin treatment is based differ from that of vaccination?

5. Often a dog is shot immediately after having bitten a person. Why is this a mistake? What would the police do in such a case? What course should be followed by the person bitten?

6. What are some of the things one should resolve to do as a result of his knowledge of the relation between typhoid and flies?

7. In locating a camp, what are some of the things to keep in mind from a sanitary standpoint?

8. Why are epidemics so frequent in the crowded tenement districts? Why do people in some cases thrive in spite of the conditions?

9. State some of the things that might happen if the state did not look after the public health?

10. Show why it is necessary for a city to build an isolation hospital.

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